TITLE: Optical Fiber Instrumentation for Slagging Coal Gasifiers

AUTHORS: Jiajun Wang, Kristie Cooper, and Anbo Wang (PI)

STUDENT: Jiajun Wang

INSTITUTION: Center for Photonics Technology
Bradley Department of Electrical and Computer Engineering
Virginia Polytechnic Institute and State University
Blacksburg, VA 24061

PHONE NO.: (540) 231 2155

FAX NO.: (540) 231 2158

E-MAIL: wangjj@vt.edu

GRANT NO.: DE-FG26-05NT42532

PERIOD OF PERFORMANCE: July, 2007 – April, 2008

DATE: May 1, 2008

1. ABSTRACT

Program Introduction: Rationale and Objective

Coal gasification, a good possibility for future clean fossil energy, has been recently studied a lot because the whole process does not generate any environmental-harmful byproduct except carbon dioxide. To control the gasification, some real time parameters need to be known, such as temperature, thickness of refractory wall of coal gasifiers. Due to the harsh environment inside the coal gasifier, traditional sensing techniques have very limited applications. We proposed optical fiber based sensors for coal gasifiers because they generally have high resolution and good resistance to harsh environment given appropriate material and packaging is chosen. The overall objective of the proposed research program is to develop an optical fiber based sensing system to monitor refractory wall thickness and temperature inside a slagging coal gasifier.

Accomplishments Achieved During the Current Period of Performance

During the current period of performance, July 2007 – April 2008, we carried out measurement experiments at 1000℃ as well as the corrosion tests at 900℃ for the thickness monitoring part. For the temperature measurement part, sensors were fabricated and calibrated up to 1400℃.

With temperature up to 1000℃, the black body radiation starts to be a problem for optical time domain reflectometer. Since the optical detector inside the optical time domain reflectometer is very sensitive, up to a level of -60dBm in this case, even a tiny amount of black body radiation coupled into optical fiber could saturate the detector in optical time domain reflectometer and thus stop the system from measuring wall thickness. A bandpass optical filter was applied to mitigate the power of detected black body radiation. In this way, reflection peaks from reference and sensing points showed up again. The software program worked as if no black body radiation had been presented. Data of a 24-hour test had a standard deviation of 5.1mm. Better accuracy was desirable by averaging multiple nearby data points.

To test how the thickness monitoring system worked with corrosive material, we used sodium carbonate to corrode the silica optical fiber at 900℃. With the corroded fiber end, the standard deviation of measured distance would increase to about 8mm. This is still good enough to tell fiber length reduction by corrosion to order of several centimeters.

For the temperature part, a sensor was fabricated. The sensor was consisted of a sapphire fiber, an alumina tube and a sapphire wafer with both sides polished. That sensor was calibrated up to 1400℃. Measured optical distance increased as temperature was raised. The plotted calibration curve agreed with the theoretical predictions very well.

Plans for the Remaining Period of Performance

The work planned for the remaining months of this research program include the following tasks:

- Integrate the thickness monitoring and temperature monitoring software programs into a single program
- Publish the outcome of these investigations.

2. LIST OF PUBLISHED JOURNAL ARTICLES, COMPLETED PRESENTATIONS AND STUDENTS RECEIVING SUPPORT FROM THE GRANT

Conference Presentations

-

Students Supported Under this Grant

- Jiajun Wang, graduate student in the Bradley Department of Electrical and Computer Engineering, Virginia Polytechnic Institute and State University.